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13. ABSTRACT (Maximum 200 words)

This project focused on the analysis of an artificial olfactory system. Light at single wavelengths is piped down a doped fiber optic causing the dyes to fluoresce. As chemicals are drawn across the doped fiber optics, they adhere temporarily to the dye and change the color of the fluorescing dye. The response is transient as the chemicals dissipate. This creates a 19-dimensional time series for each chemical species. The time series is characteristic of the stimulating chemical species. The military application of such a system extends to detecting land mines and also detecting leaking hydrocarbons from damaged military systems such as tanks and helicopters. We have demonstrated that graphical methods allow for substantial discriminating capability. Current work involves development of what we have called a d-tour, an optimization technique for finding maximal discrimination capability among a number of chemical species. The idea is to create a distance metric based on L_p–spaces with smoothers and weight functions. The d-tour is constructed in the same way as a grand tour, but in addition to touring on the data, we tour on the parameters of the smoother, of the weight function and on p, the exponent of the L_p–space.

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Papers Published Under ARO Sponsorship

Wegman, E. J. and Solka, J. L. (2002) "On some mathematics for visualizing high dimensional data," *Sanhkya (A)*, 64(2), 429-452

Wegman, E. J. (2002) "Visual data mining," *Statistics in Medicine*, 22, 1383-1397.

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Manuscripts Submitted but not yet Published

Wegman, E. J. and Dorfman, A. (2002) "Visualizing cereal world," to appear *Computational Statistics and Data Analysis*

Moustafa, R. E. A. and Wegman, E. J. (2002) "On some generalizations of parallel coordinate plots," to appear *Computational Statistics*

Wegman, E. J. (2002) "On some statistical methods for parallel computation," to appear *Handbook of Parallel Computing and Statistics*

Khumbah, Nkem-Amin and Wegman, E. J. (2002) "Data compression by geometric quantization," to appear *Recent Advances and Trends in Nonparametric Statistics*

Papers Published in Peer Review Journals

Wegman, E. J. and Luo, Q. (2002) "On some computer graphics methods for visualizing densities," *Journal of Computational and Graphical Statistics*, 11(1), 137-162

Wegman, E. J. and Symanzik, J. (2002) "Immersive projection technology for visual data mining," *Journal of Computational and Graphical Statistics*, 11(1), 163-188

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Wegman, E. J. and Symanzik, J. (2001) "Data visualization and exploration via virtual reality: An overview," *Bulletin of the International Statistical Institute*, LIX(2), 76-79

Dorfman, A. H., Lent, J., Leaver, S. G. and Wegman, E. J. (2001) "On sample survey designs for consumer price indexes," *Bulletin of the International Statistical Institute*, LIX(2), 421-424, 2001

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Wegman, E. J. (2001) "Data Reduction by Quantization," Nonparametrics in Large, Multidimensional Data Mining Conference, Dallas, TX, January, 2001

Wegman, E. J. (2001) "Visual Data Mining," 8th Biennial CDC/ATSDR Statistics Symposium, Atlanta, GA, January, 2001

Wegman, E. J. (2001), Short Course on Statistical Data Mining, ENAR Meeting, Charlotte, NC, March, 2001

Wegman, E. J. (2001) Five Lectures on Geometry, Visualization and Data Mining, University of Aalborg, Denmark, May, 2001

Wegman, E. J. (2001) "Visual Data Mining," Keynote Talk, Danish Society of Theoretical Statistics, Aalborg, Denmark, May, 2001

Wegman, E. J. (2001) "Visualizing Cereal World," DataViz II Workshop, Fairfax, VA, May, 2001

Wegman, E. J. (2001) Short Course on Statistical Data Mining, Interface '01, Orange County, CA, June 2001

Wegman, E. J. (2001)"Data Reduction by Quantization," Joint Statistical Meetings, Atlanta, GA, August, 2001

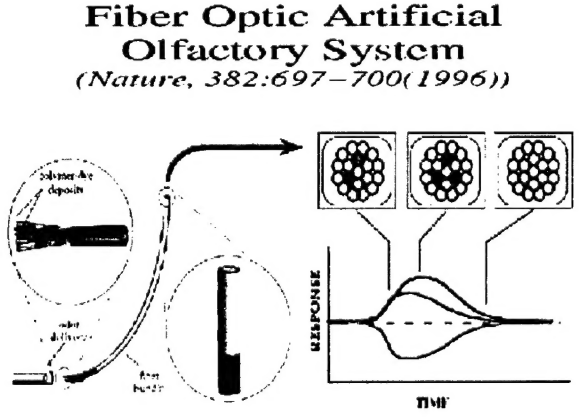
Wegman, E. J. (2001) "Pixel Tours," IMA Workshop on Geophysics and Statistics, Minneapolis, MN, November, 2001

Wegman, E. J. (2001) "Pixel Tours," American Geophysical Union Meeting, San Francisco, CA, December, 2001

Scientific Personnel Supported and Awards

Neal Glassman, Ph.D.
Eun Young Noh, Graduate Student

Scientific Progress and Accomplishments:



This project focuses on the analysis of an artificial olfactory system constructed as follows. See diagram to the left. Nineteen fiber optic stands are doped with 19 distinct fluorescent dyes. Light at single wavelengths is piped down the fiber optic causing the dyes to fluoresce. As chemicals (mainly hydrocarbons) are drawn across the doped fiber optics, they adhere temporarily to the dye and change the color (frequency) of the fluorescing dye. The response is transient as the chemicals dissipate. This creates a 19-dimensional time series for each stimulating wavelength and for each chemical species. The time series is characteristic of the stimulating chemical species. A major goal was to detect trichloroethylene, TCE, a carcinogenic agent in low concentrations and potentially in the presence of more harmless carcinogens. The military application of such a system extends to detecting decomposition products of TNT (for detection of land mines) and also detecting leaking hydrocarbons from damaged military systems such as tanks, helicopters, and other vehicles.

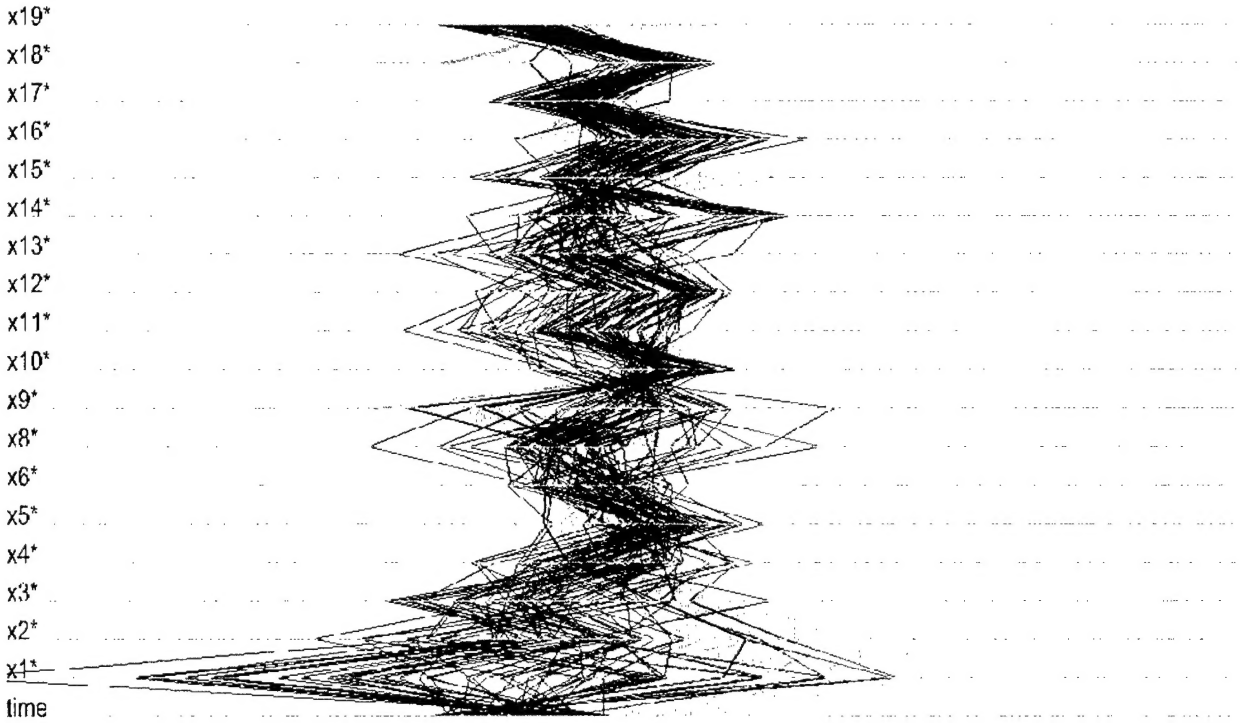


Figure 1: Parallel coordinate display of the 19 fibers after a grand tour. In this image, two chemicals, TCE and Coleman fuel, are represented respectively by red and cyan. The goal is to find variables, which are capable of discriminating between the two. In this examples x19, x18, x15, x9, x3, x2, and x1 provide substantial discrimination capability.

In our current work on this project, we have demonstrated that graphical methods allow for substantial discriminating capability. In the example illustrated here, we have found a 7-dimensional hyperplane, which appears to discriminate between the two chemicals, represented here. Current work involves development of what we have called a d-tour (or distance tour), which is an optimization technique for finding maximal discrimination capability among a number of chemical species. The basic idea is to create a distance metric based on L_p–spaces with smoothers and weight functions. The d-tour is constructed in the same way as a grand tour, but in addition to touring on the data, we tour on the parameters of the smoother, of the weight function and on p, the exponent of the L_p–space.

Note that this project was originally funded using AFOSR funds to support the research of Dr. Neal Glassman, whose expertise is in optimization. Dr. Glassman subsequently had accepted an appointment as IPA for a tour of duty for AFOSR in London so that his expertise in optimization was lost. The work described above attacked the same problem, but from a graphical perspective. The work was specifically highlighted in the paper entitled "Visual data mining."